

**UNISYS**

DATE: March 31, 1995  
TO: J. Lohr/311  
FROM: K. Sahu/300.1 *KS*  
SUBJECT: Radiation Report on: MIC4420  
Project: CASSINI/CIRS  
Control #: 11819  
Job #: EE56099  
Project part #: 5962-8877003PA

PPM-95-139

cc: E. Kidhardt/701.1  
B. Posey/300.1  
A. Sharma/311.0  
OFA Library/300.1

A radiation evaluation was performed on MIC4420 (High Speed, High Current MOSFET Driver) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a <sup>60</sup>Co gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration), and two parts were used as control samples. The total dose radiation levels were 2.5, 5, 10, 15, 20, 30, 50, and 100 krad\*. The dose rate was between 0.17 and 3.33 krad/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 krad irradiation, the parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits\*\* listed in Table III.

All parts passed initial electrical measurements. All irradiated parts passed all electrical tests up to and including the 2.5 krad irradiation level.

At the 5 krad level, S/N 7 failed the VIL\_4.5V\_MAX test and a number of other tests, which was indicative of functional failure of the part. All other irradiated parts continued to pass all electrical measurements.

At the 10 krad level, all irradiated parts continued to pass all electrical tests, except for S/N 5, 6 and 9, which marginally fell below the minimum specification limit of 0.8 V for VIL\_4.5V\_MAX, with readings of 0.63, 0.65 and 0.76 V, respectively.

At the 15 krad level, all irradiated parts fell below the minimum specification limit for VIL\_4.5V\_MAX, with readings ranging from 0.0 to 0.68 V. For all other parameters, all irradiated parts continued to pass all other electrical measurements.

At the 20 and 30 krad levels, all irradiated parts continued to show approximately the same readings as at the 15 krad level.

At the 50 krad level, S/N 6, 8 and 10 marginally fell below the minimum specification limit of 0.80 V for VIL\_18V\_MAX, with readings ranging from 0.69 to 0.77 V, and exceeded the maximum specification limit of 0.0250 V for VOL\_4.5V\_MIN, with readings of 4.5 V. For all other parameters, the irradiated parts continued to show approximately the same readings as at the 15 krad level.

\*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

\*\*These are manufacturer's pre-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

At the 100 krad level, all irradiated parts except S/N 10 exceeded the maximum specification limit of 1.500 mA for Icc\_3V\_4.5V, with readings ranging from 1.5 to 2.3 mA, and all irradiated parts exceeded the maximum specification limit of 1.500 V for Icc\_3V\_18V, with readings ranging from 1.7 to 2.9 V. All irradiated parts fell below the minimum specification limit for VIL\_18V\_MAX, with readings ranging from 0.0 to 0.66 V, exceeded the maximum specification limit for VOL\_4.5V\_MIN, with readings of 4.5 V and exceeded the maximum specification limit for VOL\_18V\_MIN, with readings of 18.0 V. S/N 5, 6, 7, 8, 9 and 10 exceeded the maximum specification limit for ROUT\_0, with readings of 51.23  $\Omega$ .

After annealing for 168 hours at 25°C, all irradiated parts recovered to within specification limits for Icc\_3V\_4.5V, but S/N 3, 6, 8 and 10 exceeded the maximum specification limit of 0.150 mA for Icc\_0V\_4.5V, with readings ranging from 0.17 to 0.29 mA. All irradiated parts recovered to within specification limits for Icc\_3V\_18V. S/N 3, 4, 5, 8 and 9 recovered to within specification limits for ROUT\_0. No other recovery was noted. After annealing for 168 hours at 100°C, no rebound effects were observed.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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TABLE I. Part Information

Generic Part Number:	MIC4420*
CASSINI/CIRS Part Number	5962-8877003PA
CASSINI/CIRS Control Number:	11819
Charge Number:	EE56099
Manufacturer:	Micrel
Lot Date Code (LDC):	9325
Quantity Tested:	10
Serial Number of Control Samples:	1, 2
Serial Numbers of Radiation Samples:	3, 4, 5, 6, 7, 8, 9, 10
Part Function:	High Speed, High Current MOSFET Driver
Part Technology:	MOSFET
Package Style:	8-pin DIP
Test Equipment:	A540
Engineer:	T. Mondy

\* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for MIC4420

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	02/10/95
2) 2.5 KRAD IRRADIATION (0.17 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT	02/15/95 02/16/95
3) 5 KRAD IRRADIATION (0.17 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	02/16/95 02/17/95
4) 10 KRAD IRRADIATION (0.57 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	02/17/95 02/21/95
5) 15 KRAD IRRADIATION (0.32 KRADS/HOUR) POST-15-KRAD ELECTRICAL MEASUREMENT	02/21/95 02/22/95
6) 20 KRAD IRRADIATION (0.31 KRADS/HOUR) POST-20-KRAD ELECTRICAL MEASUREMENT	02/22/95 02/23/95
7) 30 KRAD IRRADIATION (0.67 KRADS/HOUR) POST-30-KRAD ELECTRICAL MEASUREMENT	02/23/95 02/24/95
8) 50 KRAD IRRADIATION (0.32 KRADS/HOUR) POST-50-KRAD ELECTRICAL MEASUREMENT	02/24/95 02/27/95
9) 100 KRAD IRRADIATION (3.33 KRADS/HOUR) POST-100-KRAD ELECTRICAL MEASUREMENT	02/27/95 02/28/95
10) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	02/28/95 03/06/95
11) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/06/95 03/14/95

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS; SEE FIGURE 1.

Table III. Electrical Characteristics of MIC4420

Test #	Parameter	Units	Test Conditions	Specification	Limits
				Min	Max
1	Icc 0V 4.5V	mA	Vcc = 4.5 V, Vin = 0.0 V	0.00	0.150
2	Icc 3V 4.5V	mA	Vcc = 4.5 V, Vin = 3.0 V	0.00	1.500
3	Icc 0V 18V	mA	Vcc = 18 V, Vin = 0.0 V	0.00	0.150
4	Icc 3V 18V	mA	Vcc = 18 V, Vin = 3.0 V	0.00	1.500
5	VIH 4.5V MIN	V	Vcc = 4.5 V, Vout >2.5 V		2.40
6	VIL 4.5V MAX	V	Vcc = 4.5 V, Vout <0.025 V	0.80	
7	VIH 18V MIN	V	Vcc = 18 V, Vout >16.5 V		2.40
8	VIL 18V MAX	V	Vcc = 18 V, Vout <0.025 V	0.80	
9	VOL 4.5V MIN	V	Vcc = 4.5 V, Vin = 0.8 V		0.0250
10	VOH 4.5V MAX	V	Vcc = 4.5 V, Vin = 2.4 V	4.4750	
11	VOL 18V MIN	V	Vcc = 18 V, Vin = 0.8 V		0.025
12	VOH 18V MAX	V	Vcc = 18 V, Vin = 2.4 V	17.9750	
13	HARD VOL 4.5V MIN	V	Vcc = 4.5 V, Vin = 0.0 V		
14	HARD VOH 4.5V MAX	V	Vcc = 4.5 V, Vin = 4.0 V		
15	HARD VOL 18V MIN	V	Vcc = 18 V, Vin = 0.0 V		
16	HARD VOH 18V MAX	V	Vcc = 18 V, Vin = 4.0 V		
17	ROUT 1	Ω	Vcc = 18 V, Vin = 2.4 V, Iout = 10 mA		2.80
18	HARD ROUT 1	Ω	Vcc = 18 V, Vin = 4.0 V, Iout = 10 mA		
19	ROUT 0	Ω	Vcc = 18 V, Vin = 0.8 V, Iout = -10 mA		2.80
20	HARD ROUT 0	Ω	Vcc = 18 V, Vin = 0.0 V, Iout = -10 mA		
21	IIL 4.5V	μA	Vcc = 4.5 V, Vin = 0.0 V	-10.000	10.00
22	IIH 4.5V	μA	Vcc = 4.5 V, Vin = 4.5 V	-10.000	10.00
23	IIL 18V	μA	Vcc = 18 V, Vin = 0.0 V	-10.000	10.00
24	IIH 18V	μA	Vcc = 18 V, Vin = 18 V	-10.000	10.00

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for MIC4420 /1

# Parameters				Total Dose Exposure (krads)												Annealing								
				Initial		2.5		5		10		15		20		30		50		100		168 hrs @25°C		168 hrs @100°C
Spec. Lim./2				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
Units	min	max																						
1	Icc_0V_4.5V	mA	0	0.15	0.06	0	0.05	0	0.04	0	0.01	0	0.02	0	0	0	0	0	0	0	0.11	.12	0.04	.02
2	Icc_3V_4.5V	mA	0	1.5	0.31	.03	0.27	.03	0.22	.04	0.03	.06	0.02	.01	0.04	.02	0.13	.05	0.02	.01	1.72	.28	0.23	.08
3	Icc_0V_18V	mA	0	0.15	0.09	0	0.08	0	0.08	0	0.07	0	0.07	.01	0.07	.01	0.08	.03	0.06	.01	0.27	.59	0.08	.07
4	Icc_3V_18V	mA	0	1.5	0.44	.04	0.41	.04	0.33	.13	0.30	.12	0.30	.12	0.31	.11	0.41	.14	0.27	.10	2.11	.37	0.49	.16
5	VIH_4.5V_MIN	V		2.4	1.59	.05	1.51	.05	1.34	.23	1.04	.19	0.80	0	0.80	0	0.80	0	0.80	0	0.80	0	1.01	.09
6	VIL_4.5V_MAX/3	V	0.8		1.32	.04	1.26	.04	1.19	.06	0.88	.20	/3	/3	/3	/3	/3	/3	/3	/3	/3	/3	/3	/3
7	VIH_18V_MIN	V		2.4	1.65	.05	1.57	.05	1.49	.06	1.27	.20	1.21	.17	1.16	.15	1.07	.12	0.98	.08	0.80	0	0.84	.07
8	VIL_18V_MAX	V	0.8		1.35	.05	1.28	.05	1.22	.05	0.98	.40	0.93	.38	0.87	.35	0.79	.32	0.68	.28	0.51	.21	0.57	.23
9	VOL_4.5V_MIN	V		0.025	0	0	0	0	0	0	0.56	1.6	1.69	2.3	4.49	0	4.50	0	4.50	0	4.49	0	4.50	0
10	VOH_4.5V_MAX	V	4.475		4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.49	0	4.50	0
11	VOL_18V_MIN	V		0.025	0	0	0	0	0	0	2.25	6.4	2.25	6.4	2.25	6.4	2.25	6.4	11.3	9.3	18.0	0	18.0	0
12	VOH_18V_MAX	V	17.975		18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0
13	HARD_VOL_4.5V_MIN	V		0.025	0	0	0	0	0.56	1.6	0.56	1.6	0.56	1.6	0.56	1.6	0.56	1.6	0.56	1.6	0.56	1.6	0.56	1.6
14	HARD_VOH_4.5V_MAX	V	4.475		4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.50	0	4.49	0	4.50	0
15	HARD_VOL_18V_MIN	V		0.025	0	0	0	0	0	0	2.25	6.4	2.25	6.4	2.25	6.4	2.25	6.4	2.25	6.4	2.25	6.4	2.25	6.4
16	HARD_VOH_18V_MAX	V	17.975		18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0	18.0	0
17	ROUT_1	Ω		2.8	1.43	.02	1.44	.02	1.43	.02	1.45	.02	1.45	.02	1.46	.02	1.48	.02	1.46	.02	1.74	.04	1.52	.02
18	HARD_ROUT_1	Ω		2.8	1.43	.02	1.43	.02	1.43	.02	1.44	.02	1.44	.02	1.45	.02	1.47	.02	1.45	.02	1.74	.04	1.52	.02
19	ROUT_0	Ω		2.5	1.65	.04	1.66	.05	1.65	.05	1.65	.18	1.65	.18	1.65	.18	1.65	.18	1.65	.18	1.65	.18	1.65	.18
20	HARD_ROUT_0	Ω		2.5	1.65	.04	1.66	.05	1.65	.05	1.65	.18	1.65	.18	1.65	.18	1.65	.18	1.65	.18	1.65	.18	1.65	.18
21	IIL_4.5V	μA	-10.0	10.0	0	0	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	IIH_4.5V	μA	-10.0	10.0	0.04	0	0.04	0	0.04	0	0.04	0	0.04	0	0.04	0	0.04	0	0.04	0	0.04	0	0.04	0
23	IIL_18V	μA	-10.0	10.0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0
24	IIH_18V	μA	-10.0	10.0	0.08	0	0.08	0	0.08	0	0.08	0	0.08	0	0.08	0	0.08	0	0.08	0	0.08	0	0.08	0

Notes:

Notes:

- 1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
- 2/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
- 3/ At the 5 krad level, S/N 7 failed functionally and is not included in the statistics for the 5 and 10 krad levels. At the 15 krad level and beyond, it was not possible to obtain reliable statistics for VIL\_4.5V\_MAX. Radiation-sensitive parameters: VIL\_4.5V, HARD\_VOL\_4.5V, ROUT\_0, HARD\_ROUT\_0, VIL\_18V, VOL\_4.5V, VOL\_18V, HARD\_VOL\_18V, Icc\_3V\_4.5V and Icc\_3V\_18V.

Figure 1. Radiation Bias Circuit for MIC4420

